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ABSTRACT

The quiz and knowledge of results on the quiz have generally been found to be effective in enhancing classroom learning. The purpose of this study was to evaluate the effect of quizzing on achievement, with or without feedback. In three experimental sections quizzes were given immediately after the lesson; in three other sections quizzes were given the day after the feedback. The three conditions being used were: correct answers being given immediately; correct answers given the day after the quiz; and only the number of correct answers given to the student the following day. There was also a control section. It was found that sections receiving the delayed quiz did better on the final examination than those receiving an intermediate quiz. A short daily quiz administered one day after a lecture serves to evaluate for the student mathemagenic behaviors in which he engages during the delay. When knowledge of results is delayed, mathemagenic behaviors are also engaged in, but it is the quiz material that is being processed rather than the lecture material. The utilization of mathemagenic behaviors by the student varies according to his achievement orientation. A bibliography is appended. (Author)

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THE QUIZ, KNOWLEDGE OF RESULTS, AND INDIVIDUAL DIFFERENCES IN ACHIEVEMENT ORIENTATION

By

D. Leon Clodfelder

TECHNICAL REPORT NO. 17

Office of Naval Research Contract No. Nonr 816(14)

Naval Air Technical Training

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CHAPTER I

INTRODUCTION

Both the quiz and knowledge of results as instructional aids have been topics of studies dating back four decades. The two areas of investigation have proceeded separately, however, with few studies being concerned with the effects of both of these variables or their interaction. This state of affairs is surprising for two reasons: (1) knowledge of results or feedback has consistently been utilized with reference to the quiz; (2) both variables have been hypothesized to influence the motivation of the subject and to provide structure and practice on the material.

Recently there has been a focus on the behavior in which the subject engages while learning. Both the quiz and delayed knowledge of results are thought to enhance the facilitative effects of these behaviors on learning verbally mediated materials. Here again the investigations have proceeded separately and one cannot ascertain whether or not delayed knowledge of results would elicit or reinforce facilitative learning behavior if the quiz has already done so. The question then is to determine whether the effects of the quiz and knowledge of results are additive or redundant.

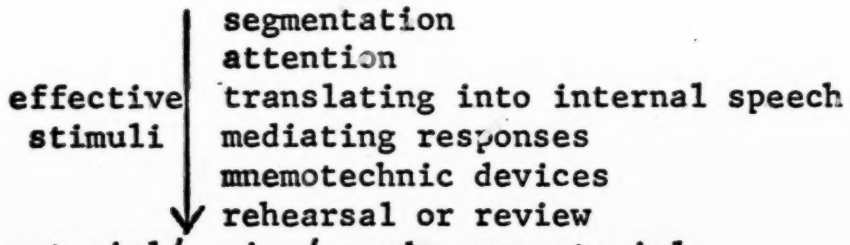
To complicate the picture further, there may be individuals whose achievement, because of their reliance on more extrinsic immediate evaluative cues, would be enhanced more by immediate feedback. Others who utilize their own intrinsic cues may indulge in the facilitative behavior which the quiz and delayed knowledge of results are thought to influence.

Thus, learning may be enhanced differentially in persons of different achievement orientations.

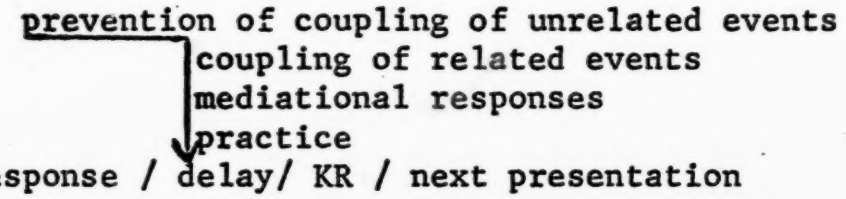
Whatever the effects of the quiz or knowledge of results on learning, it appears to be more effective if it is introduced during the acquisition process, that is, close to the time the material is first presented (Spitzer 1939; Sonces & Stroud 1940; Angell 1949; Pressey 1950; Skinner 1954, 1958; Baker, Schultz, Sullivan & Morgan 1966). It is at this time that the learner supposedly engages in behaviors which facilitate learning. According to Brackbill (Brackbill, Bravos & Starr 1962; Brackbill, Isaacs & Smelkinson 1962; Brackbill & Kappy 1962; Brackbill, Wagner & Wilson 1964), the learner utilizes mediational responses during the delay which in turn are reinforced by the delayed knowledge of results. Since Brackbill's studies were verbal discrimination tasks, the quiz was, of course, inherent in the presentation of the material. English and Kinzer (1966) used reading material and gave a quiz immediately after the reading was completed. Delay of knowledge of results on the quiz was then varied. What is important here is that the quiz was not inherent in the presentation of the material.

Rothkopf's (unpublished paper, Rothkopf 1965) paradigm for the effects of the quiz was similar to that of the delay of feedback studies. Here again the quiz was thought to reinforce the facilitative behaviors engaged in by the subject while learning. But, in contrast to the English and Kinzer study the

quiz was built into the reading of the material. Also, delay of the quiz from the reading proper was not varied but subjects were able to control this themselves. In addition, Rothkopf surmised that one could manipulate the material in such a way as to modify or alter these facilitative behaviors. The three paradigms are illustrated below:



Rothkopf: read material/ quiz / read more material



Brackbill: presentation/ S's response / delay/ KR / next presentation

English and Kinzer: read material/ quiz / delay / KR

The description of the behaviors engaged in right before or during the critical variable in all three paradigms are similar and include practice on the material, mnemotechnic devices, seeing relationships in the material, mediational responses, attention, and segmentation. One major difference, besides the fact that Rothkopf did not delay the quiz as the others did knowledge of results, is the criterion used. Whereas the delay studies used the same questions as the original quiz, Rothkopf's interest was in the generalization of the facilitative behaviors to non-repeat questions over the same material. In other words, do these mediational behaviors generalize to other material learned but not tested during acquisition? Note that in the Brackbill and Rothkopf paradigms, the behaviors evaluated or reinforced can be utilized during further presentation but not in the English and Kinzer

paradigm.

Since the studies concerned with mathemagenic behaviors and delay of knowledge of results have been with reading materials the question arises whether these results can be generalized to the lecture method used in the classroom setting. Further, the question, implied above, as to the similarity or sameness of the behaviors in the delay of knowledge studies and the Rothkopf studies has not been scrutinized. If they are tapping the same processes, then the opportunity which the subject has during learning to engage in these behaviors would be crucial. Thus, short delays between the presentation of the material and the quiz or knowledge of results would provide the opportunity for the subject to engage in behaviors which facilitate his learning and recall of the material.

When the delay, be it of the quiz or knowledge of results, is introduced, another important dimension to consider is whether the subject utilizes it to engage in facilitative learning behaviors. Not only must the opportunity arise, but the individual must make use of the opportunity. Since the dependently orientated students would be expected to rely on extrinsic guides and direction to achieve and evaluate their achievement (Cronbach 1967), it is possible that they would be less likely to engage in these facilitative behaviors. On the other hand, the more independently orientated student would be more likely to process material during the delay, or in other words, would not rely on the extrinsic direction as much.

If the criterion for learning in a classroom setting is a final examination which repeats no questions from quizzes given daily throughout the course, the following hypotheses are offered:

HYPOTHESIS 1: The effects tapped in delay of knowledge of results and use of the quiz with reading materials are generalizable to the lecture method. That is, if the person has the opportunity to engage in mathemagenic behaviors while learning from the lecture method of instruction, his final examination score will be enhanced.

HYPOTHESIS 2: Behaviors engaged in during the delay of knowledge of results are the same as those engaged in before taking a quiz. Participation in such behaviors will result in higher examination scores in either case, providing the delay of feedback is not redundant to the delay of the quiz. Hence, mathemagenic behaviors, whether maintained by delay of feedback or the quiz will be generalizable to material not specifically tested during acquisition.

HYPOTHESIS 3: Persons receiving a delayed quiz of one day after each lecture will perform better on a final examination than will those receiving either an immediate quiz or no quiz. This is because the persons receiving the delayed quiz would have opportunity to engage in mathemagenic behaviors which in turn would be evaluated or reinforced by the quiz.

HYPOTHESIS 4: Persons receiving delayed knowledge of results on an immediate quiz (i.e. directly following the lecture) will perform better on a final examination than those receiving immediate feedback. Here again the subject will have had opportunity to engage in mathemagenic behavior. The effects of delayed knowledge of results on a delayed quiz will be non-significant due to the redundancy with the delayed quiz.

HYPOTHESIS 5: As persons increase in achievement via conformity so will performance on the final exam if they are given immediate feed-

back on the quiz during learning. The immediate extrinsic direction inherent here is assumed to be more conducive to learning for these subjects.

HYPOTHESIS 6: As persons increase in achievement via independence they will perform better on a final examination under less structured conditions including a delayed quiz, delayed feedback, and no feedback. The more independent achievement orientation a person has the more he will engage in mathemagenic behaviors and intrinsic evaluations conducive to learning.

CHAPTER II

METHODOLOGY

Subjects: Subjects were 294 marines and sailors enrolled in Classes 708 and 715 of AMFU (A) school at the Memphis Air Station. This school was a four week integrated course, meaning that different subject matter was being taught at different times throughout the course. Only the physics classes were utilized in the study. Generally, one physics class involving, on the average, two class hours per day was taught the last three of the four weeks.

Method: Since the interest was in the effects of different types of treatments with the quiz and knowledge of results and their interaction a 2 x 3 random groups factorial design was set up using final examination as the dependent variable. Thus, six of nine sections of each class were used for the treatment conditions. Another section received no quiz or feedback and served as a control. The quiz was varied two ways, immediately after a lecture and delayed one day. For each variation of the quiz feedback was given in the form of the correct answer either immediately after the quiz or delayed one day. Another group received only the number right one day after taking the quiz.

In line with hypotheses one and three it was predicted that the final examination mean of the delayed quiz sections would be significantly greater than those sections receiving an immediate quiz. Hypotheses two and four predicts that there would be no difference in sections receiving different delays of feedback except the section receiving delayed feedback on an immediate quiz would be expected to have a higher mean. Hence, a knowledge of results by quiz interaction was predicted. Only the delayed quiz and immediate quiz/delayed feedback sections were

predicted to score higher on the final examination than the control section if mathemagenic behavior is the crucial variable.

To assess the differential effects of the two achievement orientation variables, a correlational technique was used (Cronbach, 1967). Since covariance of achievement orientation with mathemagenic behaviors was predicted, the two achievement scales were each correlated with criterion under different conditions. Differences in correlations were tested for significance using Fisher's z transformation. Because the achievement scales used were not orthogonal measures, a part correlation was used for statistical control of the effects of one on the prediction by the other. This, in effect, reduced the correlation between them to zero, making them orthogonal.

Following hypothesis five, Achievement via Conformity was predicted to correlate higher in sections receiving immediate feedback than in those receiving delayed or no feedback. No difference in correlation was predicted between the different quiz sections or between the delayed feedback and no feedback sections. For hypothesis six, Achievement via Independence was predicted to correlate higher in sections receiving the delayed quiz than in those receiving an immediate quiz. Likewise, Achievement via Independence was expected to correlate higher in delayed or no feedback sections than in immediate feedback sections. No difference in correlation was predicted for the no feedback and delayed feedback sections.

Measures: Five separate measures were used in the study, two of which were control measures in case different sections of the class were significantly different in general mental ability and/or initial level in

physics. Since both sailors and marines were used in the study, it was necessary to rely on different Basic Test Batteries (BTB) for each of these for a measure of mental ability. However, the Navy General Classification Test (GCT) and Marine Verbal Test (VE) are similar measures of verbal ability and correlate .83. Likewise, the Arithmetic Test (ARI) of the Navy and Arithmetic Reasoning Test (ARI) of the marines are similar measures of numerical ability and correlate .76. GCT + ARI has a distribution with a mean of 100 and a standard deviation of 18. $\frac{VE + AR}{2}$ has about the same mean and standard deviation (B. Rimland personal communication).

As a measure of initial ability a 16 item pre-test was given prior to the students' entry into the course. The school has three alternate final examinations in physics which are considered equivalent. The pretest was one such exam plus one additional item. The 46 item criterion final examination consisted of the form actually given for the final in the experimental Class plus the items given on the pretest plus fifteen items drawn from the third alternate form and the exhaustive test item pool of the school. This criterion exam had a split half reliability of .81. Quiz items given throughout the course were not repeated on the final although these items were also gleaned from the item pool plus a few constructed by the experimenter from the detailed lesson guide for the course.

The measures of achievement orientation have been briefly discussed in the review of the literature. They were the Achievement via Conformity (Ac) and Achievement via Independence (Ai) scales abstracted from Gough's California Psychological Inventory (CPI). Ac is thought "to identify those factors of interest and motivation which facilitate

achievement in any setting where conformance is a positive factor" (Gough, 1957). It is a thirty-eight item scale which differentiates between high and low achievers in high school (Gough, 1953b). The items deal in optimism, diligence, acceptance of conventions, orderliness, personal efficiency, and academic effectiveness (Gough, 1949, 1953b). Generally the scale correlates about .41 with high school grades (Gough, 1949, 1953b, 1957, 1964a; Gough & Fink, 1964), but fails to predict college grades (Gough, 1949, 1953b). This predictive power appears to be, in part, additive to mental ability as the multiple R of Ac and IQ with grade point average is higher than either taken along (Gough, 1949, 1953b, 1964a).

The Ai scale is a thirty-two item scale designed "to identify those factors of interest and motivation which facilitate achievement in any setting where autonomy and independence are positive behaviors." (Gough, 1957). Half of the items seem to be concerned with personal industriousness or absence of rigidity and the other half seem to deal with the absence of fears of, and dependence on, outside forces. The scale generally correlates about .38 with college grades (Gough, 1953a, 1957, 1964b; Barnette, 1961; Bendig & Klugh, 1956; Klugh & Bendig, 1955). Some studies indicate lower correlations with high school grades (Bendig & Klugh, 1956; Gough, 1964a; Gough & Fink, 1964) whereas another indicates about the same as for college grades (Gough, 1953a). Like the Ac scale, Ai seems to add unique variance to a multiple regression equation (Gough, 1953a, 1964b; Klugh & Bendig, 1955; Bendig & Klugh, 1956; Barnette, 1961; Rosenberg, McHenry, Rosenberg, & Nichols, 1962).

Procedure: Before entering the AMFU-A school, at the end of their preceding course, the subjects were administered the physics pretest

and the Ai and Ac scales. Students entering AMFU-A school from other sources such as the fleet, were not pretested and did not enter into the data collection. The latter did, however, take the quizzes and final along with the rest of the class. This involved about four students per section.

Subjects were assigned to their respective sections alphabetically by the school personnel. Each section was designated by a letter. The first seven sections, A through G, were used for the study with one exception. Due to the low number of students in section F of Class 708 who had been pretested, section H was substituted for section F. The treatments were as follows for Class 708:

Section A: Quiz given immediately after each lesson. Number of correct answers given to students the next day. (IN)

Section B: Quiz given immediately after each lesson. Correct answers given immediately after each quiz. (II)

Section C: Quiz given immediately after each lesson. Correct answers given next day after quiz. (ID)

Section D: Quiz given next day after lesson. Number of correct answers given to students the next day after quiz. (DN)

Section E: Quiz given next day after lesson. Correct answers given immediately after quiz. (DI)

Section H: Quiz given next day after lesson. Correct answers given next day after quiz. (DD)

Section G: Conventional class. No quiz or feedback. (Co)

In Class 715 sections A and E, B and H, and D and C were switched as to treatment and section F substituted for section G. Subjects numbered 133 for Class 708 and 161 for 715 giving a combined sample of 294.

Quizzes were begun with the first physics lesson in the middle of the second week of the course. Each quiz had four to six multiple choice items covering the material of the lesson in question. Subjects

were given five minutes to take each quiz either at the end of the lesson for the immediate quiz or before the next day's lesson for the delayed quiz. Immediate feedback was given by the subjects' opening the left margin of the test paper which had been folded back and on which the correct answer was written. They then could study the questions and answers for five minutes. For the delayed feedback conditions the left margin had been severed and before the quiz was returned preceding the next day's lesson it was stapled to the quiz paper. Again five minutes were allowed to study the questions and answers. Subjects who received only the number correct were handed slips of paper the day after taking the quiz, bearing their name, quiz number, and the number of items correct.

The fifteen items of the course final examination were administered as a part of the total course final examination. The additional thirty-one items including those of the pretest were administered the next hour on the last day of the course.

CHAPTER III

RESULTS

The data were such that they could be approached two ways. Either the data from each class could have been analyzed separately as two samples or the combined sample could have been analyzed as one. Both approaches were taken. Data from Class 715 were thus used as a cross-validation of the results from Class 708. Then the samples were combined and an analysis was made of the total sample.

The results of the 2 x 3 factorial analysis of variance for Class 708 are shown in Table 1. Only the difference in means of the quiz conditions was significant. The quiz by feedback interaction hypothesized did not approach significance nor was there significant differences among the means of the feedback groups. To assess if these results could be accounted for by heterogeneity of variance among the groups a Bartlett's test for homogeneity was applied. That test failed to reach significance so it was accepted that the groups were homogeneous in variance.

That each section receiving the delayed quiz did better on the final than did those receiving an immediate quiz is seen in the results of Duncan's New Multiple Range test summarized in Table 2. There were no significant differences at the .05 level among the three delayed quiz groups or among the three immediate quiz groups. Such results follow predictions with the exception that the immediate quiz/delayed feedback section did not approach the level of the delayed quiz as predicted. Also, the delayed quiz/no feedback mean only approached significance over the immediate quiz groups. To assess if differences

TABLE 1

Results of Analysis of Variance on Final in Class 708

Source	SS	df	MS	F
Quiz	457.41	1	457.41	16.85*
Feedback	15.99	2	8.00	---
Q x F	0.85	2	0.43	---
Within	2931.41	108	27.14	

* Significant at .01 level.

TABLE 2

Results of Duncan's New Multiple Range Test for Class 708
at .05 Level

Section	A	C	B	D	H	E
Condition	IN	ID	II	DN	DD	DI
Mean	31.48	31.61	32.00	35.00	36.05	36.06

Means connected by the same line are not significantly different.

in the treatment means with the control group mean were greater than that expected by chance a t test was used comparing each mean with the control. None of the immediate quiz means was significantly different than the control (IN, t=.58, df 38, p >.40; II, t=.26, df 36, p >.60; ID, t=.46, df 35, p >.60). Such was according to prediction except in the case of the immediate quiz/delayed feedback section. Two of the delayed quiz groups reached significance and the other approached it, (DN, t=1.31, df 36, .05 < p <.10; DI, t=1.94, df 35, p <.05; DD, t=2.02, df 36, p <.05).

The part correlations among the different quiz and feedback conditions are shown in Table 3 and the results of their comparisons are given in Table 4. Out of five comparisons in which direction was predicted, none reversed direction. That is, $r_{F(Ai.Ac)}$ was higher under the delayed quiz than the immediate quiz and higher under no and delayed feedback than under immediate feedback. Likewise, $r_{F(Ac.Ai)}$ was higher in the immediate feedback sections than in the no or delayed feedback sections. Where difference was not predicted, significance was far from reached. Three comparisons ($r_{F(Ai.Ac)}$, no vs. immediate feedback, delayed vs. immediate feedback and $r_{F(Ac.Ai)}$, immediate feedback vs. delayed feedback) were significant at the .05 level. One other ($r_{F(Ac.Ai)}$, no vs. immediate feedback) approached the .10 level of significance. The comparison of $r_{F(Ai.Ac)}$ between the quiz conditions was definitely not significant (p=.28).

The results of Class 715 did not replicate those of Class 708. The 2 x 3 factorial analysis of variance is summarized in Table 5. None of the differences was significant at the .05 level. Most of the between groups variance appears to be contributed by the low mean of

TABLE 3

Part Correlations Under Different Treatments in Class 708

Treatment	$r_{F(Ai.Ac)}$	$r_{F(Ac.Ai)}$
Immediate Quiz	.096	.116
Delayed Quiz	.209	.118
No Feedback	.252	.117
Immediate Feedback	-.133	.380
Delayed Feedback	.290	.004

TABLE 4

Comparison of Part Correlations under Different Treatments in Class 708

Comparison	z_r diff.	$\frac{z_r \text{ diff.}}{S_{z_r - z_r}}$	p
$r_{F(Ai.Ac)}$			
Delayed Quiz-Immediate Quiz	.1158	.596	.28
No Feedback - Immediate Feedback	.2410	1.624	.05
Delayed Feedback-Immediate Feedback	.4324	1.755	.04
Delayed Feedback-No Feedback	.0411	.171	.86 *
$r_{F(Ac.Ai)}$			
Delayed Quiz-Immediate Quiz	.0021	.011	.99 *
Immediate Feedback-No Feedback	.2826	1.173	.12
Immediate Feedback-Delayed Feedback	.3961	1.609	.05
No Feedback-Delayed Feedback	.1135	.471	.64 *

* When no direction was predicted a two tailed test was used.

All other comparisons are one tailed tests since direction was predicted.

TABLE 5

Results of Analysis of Variance on Final in Class 715

Source	SS	df	MS	F	
Quiz	3.95	1	3.95		
Feedback	80.28	2	40.11	1.47	p >.10
Q x F	164.55	2	82.28	3.02	p >.05
Within	3625.69	133	27.26	1.82	p >.10

the section receiving the delayed quiz with no feedback. Since this section had the lowest BTB and pretest score means, and the immediate quiz sections had a higher BTB mean than did the delayed quiz sections (115.92 vs. 113.93) an analysis of covariance with respect to BTB and pretest was applied. Those results are shown in Table 6. As can be seen the between groups variance was reduced by such an analysis as was the within groups variance, but still no significant differences obtained. However, whereas in the non-adjusted means the mean of the delayed quiz sections was smaller than that of immediate quiz sections, in the adjusted means this was not true (see Table 7).

There were two basic differences in Classes 708 and 715 besides the non-replication of the results. The total mean of the final examination score was higher for the latter (36.14 compared to 33.14). All section means in Class 715 approached the highest scores in Class 708. Also, Class 715 was generally more intelligent than Class 708 and the difference in their BTB score means approached significance ($t=1.63$, df 251; $t=1.65$ at $p=.05$).

Part correlations and the results of the correlation comparisons are shown in Tables 8 and 9 respectively. Generally, the comparisons follow the same pattern as did the results of Class 708 with two notable exceptions. The part correlation of Ai.Ac with the final was higher under the immediate quiz than under the delayed quiz sections contrary to prediction. However, this difference was not significant. Also, the difference in $r_{F(Ai.Ac)}$ between the no and immediate feedback sections failed to approach significance. Thus, three of five predicted differences were supported at the .05 level of significance or below. The correlation, $r_{F(Ac.Ai)}$, appears to have been more stable across samples.

TABLE 6

Results of Analysis of Covariance in Class 715

Source	SS'	df	MS'	F	
Quiz	.21	1	.21	---	
Feedback	18.68	2	9.34	---	
Q x F	59.15	2	29.58	1.94	p >.10
error	1997.59	131	15.25	---	

TABLE 7

Means and Adjusted Means of Sections in Class 715

Section	E	H	D	C	A	B	F
Condition	IN	II	ID	DN	DI	DD	C
Mean	36.77	37.50	35.00	33.92	36.81	37.45	35.68
Adjusted Mean	36.20	36.93	35.42	35.09	36.18	37.43	---

	Immediate Quiz	Delayed Quiz
Mean	36.31	35.97
Adjusted Mean	36.09	36.15

TABLE 8

Part Correlations Under Different Treatments in Class 715

Treatment	$r_{F(Ai.Ac)}$	$r_{F(Ac.Ai)}$
Immediate Quiz	.293	-.074
Delayed Quiz	.253	.139
No Feedback	.226	-.137
Immediate Feedback	.143	.395
Delayed Feedback	.465	-.186

TABLE 9

Comparison of Part Correlations Under Different Treatments in Class 715.

Comparison	$z_r$diff	$\frac{z_r\text{diff}}{S_{z_r - z_r}}$	p
$r_{F(Ai.Ac)}$			
Immediate Quiz-Delayed Quiz	.0432	.247	.81*
No Feedback-Immediate Feedback	.0860	.396	.35
Delayed Feedback-Immediate Feedback	.3597	1.648	.05
Delayed Feedback-No Feedback	.2737	1.262	.21*
$r_{F(Ac.Ai)}$			
Delayed Quiz-Immediate Quiz	.2140	1.224	.22*
Immediate Feedback-No Feedback	.5556	2.562	.005
Immediate Feedback-Delayed Feedback	.6059	2.777	.003
No Feedback-Delayed Feedback	.0503	.232	.82*

* When no direction was predicted or if direction went contrary to that predicted a two tailed test was used. All other comparisons are one tailed tests since direction was predicted.

The analysis of variance and covariance with respect to BTB for the combined sample are given in Tables 10 and 11 respectively. The means and adjusted means are given in Table 12. The results follow those obtained in Class 708. Only the delayed quiz/immediate feedback and the delayed quiz/delayed feedback sections contribute significantly to the between groups variance and are significantly different from the control group (DI, t=1.92, df 78, p <.025). The adjusted means of the immediate quiz sections are all lower than those of the delayed quiz sections. Again Bartlett's test for homogeneity of variance showed no significant difference among sections. Although not significant, immediate feedback sections were consistently higher on final score than were the no and delayed feedback sections in all three samples. Also, the means of the no feedback conditions were consistently lower.

Part correlations for the combined sample are given in Table 13. The comparisons of these are summarized in Table 14. Because of the larger number of subjects and the fact that the correlations were low, the differences here probably are more informative as to the hypotheses proposed. Here again, one prediction is not supported ($r_{F(Ai.Ac)}$, delayed quiz vs. immediate quiz, p=.38), three are significant at approximately the .01 level ($r_{F(Ai.Ac)}$, delayed feedback vs. immediate feedback, p=.02, and $r_{F(Ac.Ai)}$immediate feedback vs. no, p=.005, and delayed feedback, p=.001) and one is not clear cut ($r_{F(Ai.Ac)}$, no feedback vs. immediate feedback, p=.10). All five in which direction was predicted were in that direction. Those in which no differences were hypothesized failed to elicit significant differences.

TABLE 10

Results of Analysis of Variance for Combined Sample

Source	SS	df	MS	F
Quiz	175.94	1	175.94	5.94*
Feedback	86.79	2	43.40	1.47
Q x F	89.13	2	44.57	1.51
Within	7313.04	247	29.61	---

* Significant at .05 level

TABLE 11

Results of Analysis of Covariance for Combined Sample

Source	SS	df	MS	F
Quiz	187.41	1	187.41	7.36*
Feedback	93.29	2	46.65	1.83
Q x F	10.78	2	5.39	.21
Within	6260.51	246	25.45	---

* Significant at .01 level

TABLE 12

Means and Adjusted Means of Combined Sample

Condition	IN	II	ID	DN	DI	DD	C
Mean	34.19	34.82	33.61	34.39	36.50	36.77	34.22
Adjusted Mean	33.82	34.82	33.89	34.83	36.67	36.16	---

TABLE 13

Part Correlations Under Different Treatments for Combined Sample

Treatment	$r_{F(Ai.Ac)}$	$r_{F(Ac.Ai)}$
Immediate Quiz	.194	.072
Delayed Quiz	.230	.123
No Feedback	.232	.010
Immediate Feedback	.035	.390
Delayed Feedback	.360	-.100

TABLE 14

Comparisons of Part Correlations Under Different Treatments for Combined Sample

Comparison	$z_r$diff	$\frac{z_r\text{diff}}{S_{z_r - z_r}}$	p
$r_{F(Ai.Ac)}$			
Delayed Quiz-Immediate Quiz	.0377	.295	.38
No Feedback-Immediate Feedback	.2013	1.281	.10
Delayed Feedback-Immediate Feedback	.3419	2.149	.02
Delayed Feedback-No Feedback	.1407	.895	.37*
$r_{F(Ac.Ai)}$			
Delayed Quiz-Immediate Quiz	.0515	.403	.69*
Immediate Feedback-No Feedback	.4018	2.556	.005
Immediate Feedback-Delayed Feedback	.5121	3.219	.001
No Feedback-Delayed Feedback	.1103	.702	.48*

* When no direction was predicted a two tailed test was used.

All other comparisons are one tailed tests since direction was predicted.

a type I error was made in Class 708 wherein the null hypothesis was rejected when it was in fact true. Coupled with this is the possibility that the three sections receiving the immediate quiz just happened by chance to be the poorest physics students of that particular class. The probability of making a type I error was, of course, .01. Out of a set of six groups, three can be combined, disregarding order, twenty ways. Thus, the probability of all immediate quiz groups combining with lower means with just chance operating would be 1/20 or .05. Including the control this probability would be 1/42 or .024.

A second possibility stems from lack of control over the instructor variable. It will be recalled that instructors were switched in the replication. If the instruction was contributing totally to the between quiz variance, then the delayed quiz conditions should have scored lower in the replication. This was not the case. However, if both the instruction and the delayed quiz treatment was operating, then in the replication, these effects would have cancelled each other out. If this were so, one would expect that the means of Class 715 would be somewhere in between the immediate and delayed means of Class 708. This was not the case since the means of Class 715 were as high as the highest means of Class 708.

A third explanation would be in terms of the higher intelligence level of Class 715. Noll (1939) pointed out that tests had a tendency to help students of lower intelligence levels, but not affect those of higher intelligence. Class 715 could very well have been above the intelligence level conducive to experimental effects. The reflection of higher final scores could be interpreted in this light.

The fourth possibility influencing the replication is related

to the third and also would reflect overall higher scores. This has to do with the change in conditions of AMFU-A school. Class 708 was essentially a naive class in that it was the first class used for any experimentation for quite some time. However, in between 708 and 715 every class was involved in some kind of research. Essentially, this made the instructors "research tired" and probably less conscientious about controls than they had been previously. In addition, the attrition via failure rate was rising and there was extra effort on the part of the school and instructors to teach the material. Such "added" treatments could well have cancelled the effects of the experimental conditions found in Class 708.

If the assumption is made that the differences found in Class 708 are real differences, and are due to the influence of the treatments on mathemagenic behaviors then one must deal with the lack of support for the hypothesis that delay of informational feedback provides the same opportunity as the delayed quiz. One can interpret this that either the behaviors elicited are different or the material processed is different. What may be going on in the delay of feedback period is only a practice, rehearsal, or memorizing the questions on the quiz. Such would serve only to increase the effective number of trials on the quiz and may enhance a post-test score on the same questions. Another alternative is that the behaviors are the same but the material processed is different. This can be seen diagramatically below:

Condition ID: lecture/quiz/process quiz during delay/ informational feedback

Condition IQ: lecture/process lecture during delay/quiz/ information feedback

What is being assumed here is that the student would behave mathemageni-

cally with respect to the presentation immediately before the delay. In the immediate quiz/delayed feedback paradigm this would be the material on the quiz. In the delayed quiz paradigm the material of the lecture would be processed during the delay. Since the questions on the final were different than those on the daily quizzes, the mathemagenic behaviors of the delayed feedback paradigm would not be as pertinent except in so far as the questions are directly transferable.

The failure of $r_{F(Ai.Ac)}$ to be differentially reflected under immediate and delayed quiz conditions may be due to a design error. Each of these quiz samples included no, immediate, and delayed feedback conditions and the correlation could have reflected the average of these rather than any influence of the quiz condition. However, the quiz was varied independently in that the feedback conditions were equal in each quiz condition.

On the other hand, Ai may not correlate differentially under the immediate and delayed quiz conditions just as the data implies. Thus, differential $r_{F(Ai.Ac)}$ or $r_{F(Ac.Ai)}$ may reflect only the presence of structure vs. non-structure and not be related to mathemagenic behavior. But an erroneous assumption is made here, namely, mathemagenic behavior does not go on under immediate quiz conditions. Such an assumption is contradictory to the prediction of enhanced learning under delayed feedback conditions and the discussion above concerning it. Thus, what may be important is not the presence or absence of mathemagenic behaviors, but the facilitative or detrimental effects of such. In so far as mathemagenic behaviors are engaged in on the quiz material, if the criterion test is of the same type (i.e. a buoyancy problem with just the numbers changed) then Ai.Ac, assumed to include the engagement of mathemagenic behaviors, would correlate with criterion. However, the amount of positive trans-

ference would be less or in other words, the mean of the immediate quiz groups final scores would be lower which was what was found.

The conceptualization of the function of quiz and feedback is given below:

I N: lecture/quiz/processing of quiz

I D: lecture/quiz/processing of quiz/information as to behavior on quiz

D N: lecture/process lecture/quiz, or test of mathemagenic behaviors utilized in taking quiz

D I: lecture/process lecture/quiz; same as D N/information as to correctness of mathemagenic behavior results

D D: same as D I except the student has to wait for informational feedback

In the immediate quiz conditions, the quiz thus functions in lieu of the person's own processing of the lecture material. Informational feedback would thus reinforce behavior on the quiz or shortly thereafter if it is delayed. In so far as these are conducive to learning material inherent in the criterion final, then they will influence positively the final score. In the event that no feedback is given, then behaviors detrimental to criterion, engaged in during the quiz, do not drop out unless the subject searches for or receives this information on his own. Hence, the consistent, although statistically insignificant, lower means in the no feedback sections.

In the delayed quiz paradigm, the quiz serves as a means of utilizing the mathemagenic behaviors engaged in during the delay. So, actually different kinds of behavior are being tested. Here again informational feedback serves to reinforce the behavior on the quiz, but in the delayed quiz this behavior is assumed to be more facilitative and generalizable. The non-facilitative behaviors utilized during the quiz

are dropped out with informational feedback.

This study was only an exploratory one designed to assess whether something like mathemagenic behaviors are inherent in the learning of lecture materials as it is proposed to be in reading materials. If one can accept that the results suggest that such is possible, two steps in further study are indicated. The first, of course, is a delineation of what constitutes these behaviors. The suggestions from reading material studies could be helpful here plus students own reports as to how they learn material. The second step is to study ways that these behaviors can be maximized in the classroom situation. Two directions are possible. (1) The lecture can be so organized to build into it the facilitative behaviors for the student. This is essentially what Rothkopf has done with reading materials (Rothkopf, 1965; Rothkopf & Coke, 1963, 1966) and what Cronbach (1967) has proposed in dealing with individual differences. In other words, the lecture would be organized so that the relations intended would be drawn by the student and the important material picked out. Such an approach would be difficult, especially if individual differences prevail in students as well as in instructors. Another approach might be to teach mathemagenic behaviors in courses of study skills, listening, taking notes, reading, etc. with the assumption or hope that these would generalize to the behavior in the classroom. In any case, the attempt would be made to understand how the organism is learning instead of the material he is learning.

In line with the purpose and the results of this study the following conclusions are offered:

1. A short daily quiz administered one day after a lecture serves to evaluate for the student mathemagenic behaviors in which he engages

during the delay. Those behaviors which are facilitative to learning are reinforced whereas those which are detrimental to learning are eliminated.

2. When knowledge of results are delayed, mathemagenic behaviors are also engaged in, but it is the quiz material that is being processed rather than the lecture material. Hence, the transfer of learning to different questions on the final examination is not as great as in the case of the delayed quiz.

3. The utilization of mathemagenic behaviors by the student varies according to his achievement orientation. Persons with an independent orientation are more likely to engage in mathemagenic behaviors and rely on their own intrinsic evaluations. Persons with a dependent orientation are more likely to seek extrinsic guidance and evaluation in the form of immediate feedback and rely less on themselves.

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13. ABSTRACT

The quiz and knowledge of results on the quiz have generally been found to be effective in enhancing classroom learning. The purpose of this study was to evaluate the effect of quizzing on achievement, with or without feedback. In three experimental sections quizzes were given immediately after the lesson; in three other sections quizzes were given the day after the feedback. The three conditions being used were: correct answers being given immediately; correct answers given day after the quiz; and only the number of correct answers given to the student the following day. There was also a control section.

It was found that sections receiving the delayed quiz did better on the final examination than those receiving an intermediate quiz. A short daily quiz administered one day after a lecture serves to evaluate for the student mathemagenic behaviors in which he engages during the delay. When knowledge of results is delayed, mathemagenic behaviors are also engaged in, but it is the quiz material that is being processed rather than the lecture material. The utilization of mathemagenic behaviors by the student varies according to his achievement orientation.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Educational Achievement						
Training Gain						
Achievement Orientation						
Knowledge of Results						
Mathemagenic Behavior						

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